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REMARKS

Claims 30-44 are all the claims pending in the application. Claims 21 and 25-29 are canceled and claims 39-44 are added, above. Claims 30-38 stand rejected on prior art grounds. Applicants respectfully traverse these rejections based on the following discussion.

I. The Prior Art Rejections

Claims 30-38 stand rejected under 35 U.S.C. §102(b) as being anticipated by Rostoker (US Patent No. 5,662,768) and by Oehrlein et al. (US Patent No. 5,153,813). Claims 27-29 stand rejected under 35 U.S.C. §102(e) as being anticipated by Nguyen et al. (US Patent No. 6,027,968). This rejection and rendered moot by the cancellation of claims 27-29. Applicants respectfully traverse the remaining rejections based on the following discussion.

A. The Rejection Based on Rostoker

The Office Action states that in independent claim 30, Rostoker discloses an opening (trench) having a first portion and a second portion, wherein the second portion has a larger dimension that the first portion, and a conductor filling 32 the opening (trench). The Office Action further states that all portions have the appearance of a rectangular shape.

However, Rostoker discloses trenches having high surface-area sidewalls with undulating profiles, as opposed to rectangles. Such trenches are formed by first implanting multiple vertically separated layers of dopant in a substrate beneath a region where the trench is to be formed. Next, the trench is formed under conditions chosen to selectively attack highly doped substrate regions (i.e., substrate regions where the dopant has been implanted). The resulting trench sidewalls will have undulations (not rectangles) corresponding to the positions of the implanted regions. In one case, the implanted layers contain germanium ions, and a trench is aniostropically etched through the layers of germanium. Thereafter, the trench is subjected to oxidizing conditions to form regions of germanium oxide. Finally, the trench is exposed to an aqueous solvent which dissolves germanium oxide, disrupting the silicon lattice, and leaving gaps or undulations in the sidewall.

Thus, Rostoker merely discloses a single opening that includes undulating walls (Figure 1f) or a single oval opening 28, 44 (Figures 2c and 4). To the contrary, the invention defined by independent claim 30 includes two rectangular portions, as shown in Applicants' Figure 10. This bottle-shaped structure provides a number of advantages including increased surface area and increased capacitance. Since Rostoker is limited to trenches with undulating walls or to a single oval opening, it cannot teach (much less suggest) the invention as defined by independent claim 30. Therefore, independent claim 30 is not anticipated by Rostoker.

Further, Rostoker does not disclose the invention defined by independent claim 35 that claims a structure that has a first rectangular portion 81, a second rectangular portion (between regions 20) and a third rectangular portion 80, as shown in Applicants' Figure 8. Once again,

Rostoker is limited to a single trench with undulating sidewalls or to a single oval opening. There is no structure even remotely similar to the structure shown in Applicants' Figure 8 (that is defined by independent claim 35) in Rostoker. Therefore, independent claim 35 is also not anticipated by Rostoker.

In view of the forgoing, Applicants respectfully submit that independent claims 30 and 35 are not anticipated by Rostoker and are patentable over Rostoker and the remaining prior art of record. Further, dependent claims 31-34 and 36-38 are similarly patentable, not only by virtue of their dependency from a patentable independent claim, but also by virtue of the additional features of the invention they define. In view the forgoing, the Examiner is respectfully requested to reconsider and withdraw this rejection.

B. The Rejection Based on Oehrlein et al.

The Office Action states that in independent claim 30, Oehrlein discloses an IC having at least one trench capacitor, wherein the capacitor comprises an opening (trench) 30 having a first rectangular portion and a second rectangular portion, wherein the second rectangular portion has a larger dimension than the first rectangular portion, and a conductor filling the opening (trench). The Office Action notes that the labeling of each portion, first or second, is based on the altering position of the lateral openings 28, thereby meeting the claim's limitation.

The Office Action states that in independent claim 35, Oehrlein discloses an opening (trench) 30 having a first rectangular portion, a second rectangular portion, and a third portion,

wherein the second rectangular portion has a larger dimension than the first and third rectangular portion, and a conductor filling the opening (trench).

However, Oehrlein actually discloses a capacitor which comprises a main vertical trench and lateral trenches extending off the main vertical trench. The capacitor has alternating first and second silicon regions, for example n-doped and p-doped silicon regions. After a main vertical trench is dry etched through the first and second silicon regions, the etch characteristics of the alternating first and second silicon regions are utilized to selectively dry etch lateral trenches, thereby increasing the surface area of the capacitor and the capacitance of the capacitor.

Thus, Oehrlein merely discloses a single opening that includes walls having recesses (Figures 1b and 2b). To the contrary, the invention defined by independent claim 30 includes two rectangular portions, as shown in Applicants' Figure 10. This bottle-shaped structure provides a number of advantages including increased surface area and increased capacitance. Since Oehrlein is limited to trenches with walls having recesses, it cannot teach (much less suggest) the invention as defined by independent claim 30. Therefore, independent claim 30 is not anticipated by Oehrlein.

Further, Oehrlein does not disclose the invention defined by independent claim 35 that claims a structure that has a first rectangular portion 81, a second rectangular portion (between regions 20) and a third rectangular portion 80, as shown in Applicants' Figure 8. Once again, Oehrlein is limited to a single trench with sidewalls that have recesses. There is no structure even remotely similar to the structure shown in Applicants' Figure 8 (that is defined by

independent claim 35) in Oehrlein. Therefore, independent claim 35 is also not anticipated by Oehrlein.

In view of the forgoing, Applicants respectfully submit that independent claims 30 and 35 are not anticipated by Oehrlein and are patentable over Oehrlein and the remaining prior art of record. Further, dependent claims 31-34 and 36-38 are similarly patentable, not only by virtue of their dependency from a patentable independent claim, but also by virtue of the additional features of the invention they define. In view the forgoing, the Examiner is respectfully requested to reconsider and withdraw this rejection.

C. The Rejection Based on Nguyen et al.

As mentioned above, this rejection is rendered moot by the cancellation of claims 27-29.

II. Formal Matters and Conclusion

In view of the foregoing, Applicants submit that claims 30-44, all the claims presently pending in the application, are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

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Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary.

Please charge any deficiencies and credit any overpayments to Attorney's Deposit Account Number 50-0510.

Respectfully submitted,

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Date: 12/6/02

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Marked Up Version of Changes Made:

30. (Amended) An integrated circuit structure comprising:

a substrate;

an opening in said substrate, said opening [comprising] consisting of a first rectangular portion and a second rectangular portion, wherein said second rectangular portion has larger dimensions than said first rectangular portion; and

a conductor filling said opening.

35. (Amended) An integrated circuit structure comprising:

a substrate;

an opening in said substrate, said opening [comprising] consisting of a first rectangular portion, a second rectangular portion, and a third rectangular portion, wherein said second rectangular portion has larger dimensions than said first rectangular portion and said third rectangular portion; and

a conductor filling said opening.

Please add the following new claims:

39. The integrated circuit in claim 35, wherein said first rectangular portion and said third rectangular portion have different dimensions.

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40. An integrated circuit structure comprising:

a substrate;

a bottle-shaped opening in said substrate, said bottle-shaped opening comprising a first rectangular portion and a second rectangular portion, wherein said second rectangular portion has larger dimensions than said first rectangular portion; and

a conductor filling said opening.

41. The integrated circuit in claim 40, wherein said second rectangular portion is deeper in said opening than said first rectangular portion.

42. The integrated circuit in claim 40, wherein said first rectangular portion is deeper in said opening than said second rectangular portion.

43. The integrated circuit in claim 40, wherein said lateral openings increase a surface area of said trench capacitor.

44. The integrated circuit in claim 40, wherein said lateral openings increase a capacitance of said structure.